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THE SPRING DECUS MEETING HELD AT HARVARD UNIVERSITY AND A VISIT TO DIGITAL EQUIPMENT CORPORATION AT MAYNARD, MASS.

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This report describes the highlights of the DECUS Meeting and a visit to the manufacturers of the on-line computer in use in our laboratory.

The plant of Digital Equipment Corporation in Maynard, Mass., reminds one in many respects of the Carleton Place plant of Digital Equipment of Canada Limited. The U.S. parent company's plant is also in an old woollen mill. It was previously used for the manufacture of all woollen goods used by the U.S. Armed Forces, and had its hey-day in blanket manufacturing during the American Civil War. Only part of the complex of the former woollen mill is used by Digital and many other firms also occupy these buildings. Five floors are occupied by Digital of which three are used for computer manufacture, one is used for module production and the ground floor is occupied by offices and the operating area for the in-house PDP-6. Together with Jack Richardson of Digital Equipment of Canada Limited, the author toured the plant and saw all aspects of its operation. These will be described in turn beginning with module production. While the true integrated circuits are only available in certain figurations, namely those used for the PDP-8, there is an

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extensive production of discrete component flip-chip-like modules. The complete production facilities for the modules includes a printed circuit manufacturing plant, automatic eye-letting and punching machines and automatic inserting machines. These machines work on a metal template which is etched at the same time as the printed circuit master. The operator simply guides the stencil around this pattern and automatically inserts resistors, diodes and other small components. Hand assembly is used for transistors and capacitors since these are not of a uniform size. Each module is individually tested using a PDP-4 and a special testing facility. All parameters of the module are measured and it is accepted on a GO, NO-GO basis. Where pulse height and waveform are important,modules are individually examined on Tektronix oscilloscopes. There was an impressive array of these - about 40 - in the check-out area for modules. The integrated circuit elements are only made in one form as yet, this being essentially a capacitor diode gate. This capacitor diode gate is extensively used in the PDP-8 and all production of these integrated circuits are for the computer. It is thought that it will be at least six months before flip-chip integrated circuits will be available in other module series. The engineering of new modules was discussed with Mr. Russ Doane of the Digital Engineering Section. He stated that new capacitor diode gates using seven diodes instead of five will be made available soon. This will eliminate the problems involved with over-shoot. Mr. Doane did not think that there would be extensive development of high density modules such as the 4222 systems module

since there is a definite limit on the number of output connections available. He thought that these would probably be a more extensive line of the 10 megacycle B series modules, although this would take some time. After visiting Mr. Doane, a discussion was held with Mr. Dick Sorenson of the Applications Engineering Section on analog-to-digital conversion techniques. There are many tricks in this game which are not apparent from reading Digital manuals, some of these were outlined by Mr. Sorenson. One of the chief problems is eliminating the noise inherent on the power lines of the digital logic. Two separate grounds must be defined, one for digital ground and the other for analog ground. This analog ground should be kept free from noise and grounded at a definite location in the system preferably near the least significant bit. There are also some problems in using the A502 comparator but these involve chiefly attention to signal pickup problems and isolation from high-current devices. Since the A502 operates on a millivolt sensitivity it is not surprising that it is very susceptible to pickup. There have been several changes in the design of the A601 and A604 modules since they were first announced. These again involve chiefly more attention to grounds and pin S, for these modules is reserved for an analog ground system. Digital Equipment in the United States has built several 13-bit convertors with little difficulty and since most of our requirements are for 12-bit devices there should be no difficulty in getting these operating. The pre-loading of an A704 power supply is essential to its operation in its recommended current range. This is accomplished by connecting a 330-ohm resistor between the output

and ground.

After visiting the Engineering Department we went to the computer checkout floor. There were three PDP-6's on checkout, numerous PDP-7's and a few PDP-8's. The United States demand for PDP-7 has far exceeded the company's initial expectations and these computers are dominating the production facilities at the present time. It is thought that in the near future, PDP-8's will require essentially as much effort. We spoke with Mr. Ed DeCastro the designer of the PDP-8 and also the PDP-5. He is still working on improvements in the PDP-8 which will be made in the field to those already delivered. Several problems have arisen in the high speed logic and as Mr. DeCastro is constantly trying to reduce the cycle time, improvements in both the central processor and memory control unit will continue to be made for some time. We discussed the possibility of modifying the PDP-5 to use a hardware program counter, but this appears to be very difficult in that the appropriate lines are not available on the rack. In order to operate the hardware program counter with the PDP-5 the 4606 modules would require an extra connector added on their end. This seems rather cumbersome although the factor of two in memory cycle time is extremely attractive. There appears to be similar problems in putting a hardware protect circuit in the memory of the PDP-5, while with the PDP-8 these problems would not occur since there is a separate hardware program counter. The entire atmosphere of Digital Equipment Corporation was one of unhurried work; no one seemed to be rushing madly and there seemed to be no

pressure to keep on the job. While this impression of quiet calm existed it was coupled with the realization of the substantial number of units being produced by perhaps a thousand people. There is an equal number who are in engineering, software and module production.

After discussing computers we went to visit Mr. Jack Ridgeway of the Applications Programming Section. We discussed various problems connected with program assembly language (PAL), symbolic tape editor (STE) and the binary punch (BP). He said that the company is working on many of these and Mr. Jack Richardson of Digital Equipment of Canada Limited is now in the process of modifying the symbolic tape editor so that it can be used with any combination of high and low speed punches or readers. Several programs were obtained from the Digital Program Library with the assistance of Miss Joan Cowles. These include DDT-8, a symbolic debugging routine and a tape duplicator for the high speed reader-punch assembly. The visit to Digital Equipment Corporation was most interesting in that it showed the number of people involved in producing machines as small as the PDP-5 and PDP-8.

The next day was the opening of the Digital Equipment Computer Users Society (DECUS) Symposium held at William James Hall, Harvard University. An opening welcome was given by Dr. D. Norman of the Psychology Department, Harvard University. William James Hall has been erected at the University centre for cognitive studies and Dr. Norman is one of the principal workers in this field at Harvard. A welcome by Mr. Harlan Anderson, Vice-President of Digital Equipment Corporation, followed the welcome by Dr. Norman. Mr. Anderson

discussed what the next three years in the Digital Equipment line of computers would bring. He thought that the module production would be standardized on integrated circuits and modules would become faster but saw no real need in the near future for altering their line of computers. In other words the PDP-9 is a long way away. He saw major improvements in software and saw an increased emphasis on large scale computers. This is not surprising since the company's first big computer, the PDP-6, has just recently been delivered and several more are on order. Mr. Anderson also predicted an increased use of on-line computers for data acquisition and stated that the company would become more involved in this field. It seems that Digital is going two ways, a rather dichotomy in fact of very large computers and very small computers with nothing in between.

The first paper of the session was given by Professor F.A. Coones of M.I.T., who discussed project "sketch pad". This uses a very large computing facility as an automatic drafting and engineering design system. Professor Coones' talk was illustrated by three movies of the design procedure as applied to designing a ship's hull and the wing of an aircraft. Chief impetus for this type of work has come from the aircraft industry who employ many thousands of people in a drafting department drawing parts for large military and commercial aircraft. With a system such as project "sketch pad" the number of draftsmen could be reduced and the number of errors reduced correspondingly. It is hoped eventually that the computer will be able to produce cards which will be used to control lathes,

milling machines etc.

The next paper was by C.W. Stein of the Digital Equipment Corporation. He discussed the automated designing of electronic circuits using a system similar to that of Professor Coones. This system called DECADE, standing for Digital Corporation's Automatic Design System, has been used for the design of the PDP-7. The logic of the computer of the computer is sketched on the screen of an oscilloscope and the PDP-4 then produces a set of cards which allows the controlling of the automatic wire wrap machine.

There were several talks on high speed man-computer communication systems, automatic drafting devices and similar systems. One is truely amazed at the progress in this field and it is completely beyond the experience of the author to evaluate such devices. There were three papers given which were directly related to physics experiments; one given by the author on Mössbauer effect; one given by Sypko Andreae of Lawrence Radiation Laboratory discussing the use of a PDP-5 in connection with the 88-inch cyclotron and the cosmotron; and the third presented by Dr. Dallas Santry of Chalk River Nuclear Laboratories on the Chalk River PDP-5 pulse height analyzer. There were several on the use of on-line computers for reduction of data from cloud chamber and spark chamber photographs. These are still very much in the developmental stage and have not as yet been used for experiments.

Dr. Margaret E. Law of the Cambridge Electronic Accelerator, C.E.A., guided the author around this very massive installation. They

recently had a fire which destroyed the Linac front end and thus the accelerator was not in operation. This installation provides a beam current of several microamp of 6 BeV electrons and has primarily been used for studying electron scattering phenomena and for the production of high energy gamma photons or Bremsstrahlung. This latter application is the prime function of the accelerator and the chief study is in (γ, p) reactions. These reactions are studied by means of a large hydrogen bubble chamber, spark chambers and various other high energy devices. Dr. Law stated that they were using a PDP-1 as a track scanner although as yet most of their scanning is done manually. There were between fifteen and twenty experiments in progress or under construction for use with the Cambridge Electronic Accelerator. The heavy bridge-work type engineering involved in performing high energy experiments was particularly evident at this accelerator installation. There were several spectrometers with a radius of curvature in the order of 20 to 30 feet and these could swing large Cerenkov counters of diameters 2 to 3 feet around any quadrant of a sphere. The output of the accelerator, in the form of high energy electrons, could be beam-switched to any of four or five experimental locations and most experimenters had two to three runs per year on the accelerator. The remainder of the time was involved in data analysis. While the actual staff of the C.E.A. is rather small many visitors from M.I.T., Rutgers and Yale use the facilities of the accelerator and it is in demand most of the time.

The Air Force Cambridge Research Labs, A.F.C.R.L., were

visited and in this establishment an automatic drafting machine was demonstrated, many of whose functions were very similar to that performed by a normal draftsman. The machine had been programmed to produce parallel perpendicular lines and lines at any given angle. These functions were all determined by the operation of a light pen on the screen of the oscilloscope and thus this device in many ways parallelled the functions performed by a typical draftsman. There were some problems with the system and it is not yet used in a commercial application. The cost of this system is roughly $250,000, and it is therefore only in extremely large installations that this type of device will become practical.

The next day's sessions of DECUS meeting were primarily on bubble chamber and spark chamber photographs and their interpretation using small on-line computers. The problems in this field are immense and much progress has been made in recent years on the automatic interpretation of these pictures. Previously these pictures were all interpreted by hand using scanning microscopes.

This meeting was clearly divided into two subject interests, those of the large scale computer user and software development, and the small computer user and his needs for on-line computers. There is very little common ground between these two other than that they use equipment made by the same company. There is much discussion within the DECUS organization about changing the nature of their meetings to have one for small computer users and the other for large computer users. The meeting was attended by roughly a hundred people of whom eighty were interested in large computer development.